Development of anerobic digestion for swine waste management

Thomas D. Hayes* Vipul J. Srivastava, J. Robert Paterek, and John R. Conrad
Gas Technology Institute, Des Plaines, IL
Phone: 847.768.0500 Fax: 847.768.0546

Anaerobic digestion is a biological process that can potentially provide multiple benefits for swine raising operations throughout the United States. The production of pork is a major agricultural enterprise in the United States with an animal inventory that ranges between 50 and 70 million swine in a 4 to 7-year production cycle.[1,2] By 1980, over 21 percent of the growing-finishing pigs (pigs raised from 12 to 100 kg for meat production) and 50 percent of the nursing and nursery pigs in the U.S. were located in confinement facilities with liquid manure handling systems. In view of new confinement construction that continued over the last 20 years (led by the regions of Iowa and North Carolina), it is predicted that the safe management and disposal of liquid manure will be increasingly important to the pork industry. Larger production systems of over 1,000 head of swine are the fastest growing segment of the industry; in 1988, large swine operations of 1,000 head or more accounted for more than 60 percent of the market hogs. A single swine operation of 20,000 head produces more organic waste sludge than a town of 100,000 people, amounting to over ten million gallons of sludge per year. For most of the swine industry, anaerobic digestion offers multiple potential benefits including: 1) significant energy production (biogas), 2) nutrient conservation, 3) pathogen reduction, and, 4) removal of soluble contaminants that pose risks to groundwater and surface waters.

To realize these benefits, the U.S. DOE is supporting the Gas Technology Institute (GTI) in an effort to develop anaerobic digestion processes for the treatment of swine waste that have the potential of providing significant energy, environmental and economic advantages for the swine raising industry. The overall objective of the work in Phase I is to evaluate the capabilities of two-phase and single-stage digester designs and to identify a cost effective digester design that provides the greatest performance benefit in the conversion of swine manure. A hypothesis of this effort is that the GTI's two-phase digestion system, called ACIMET, can outperform single stage conventional digestion designs in terms of acceptable loading rates, conversion rates of organics and in terms of methane yield. This hypothesis is based on GTI's experience in applying the ACIMET digestion system to the treatment of sewage sludge at pilot and full scale where ACMET has delivered significantly higher methane yields at twice the organic loading rates applied to conventional digestion (exceeding 4 kg/m^3/d). The ACIMET digestion system has been operating at full scale on municipal sludges for more than 7 years at the POTW located at Woodridge, Illinois.[3]

Acimet Process at Woodridge, IL

A number of two-phase and single-stage anaerobic digesters were operated on manure collected from swine operations. The test protocols and measurements taken from these units were designed to allow comparisons of performance between the two-phase and the single stage digester systems. Measurements have allowed mass balances, calculations of methane yield and estimations of kinetic rates of conversion. This information will be presented and the rationale for the selection of the digester design for further process development and scaleup on swine manure applications will be discussed. Based on information collected to date, methane yields of greater than 0.3 m^3 per kg volatile solids added (5.0 ft^3 per lb volatile solids) is achievable with both two-phase and single stage digesters in the conversion of swine manure. This is equivalent to a total volatile solids conversion efficiency of more than 60 percent. Nutrient

analysis and pathogen measurements will also be presented to indicate the potential of the digestion process to deliver multiple benefits in the management of swine manures.

A preliminary engineering analysis of the economics of the anaerobic digestion process applied to swine operation manures will also be presented.

References

1. Overcash, M.R., and F.J. Humenik. 1976. State of the art: swine waste production and pretreatment processes. U.S. Environmental Protection Agency Technology Series EPA-600/2-76-290.
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3. Srivastava, V.J. 1996. Two-phase anaerobic digestion of carbonaceous organic materials. U.S. Patent 5,500,123.

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